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# EVALUATION OF GRASSHOPPERS IN PINE PLANTATIONS, GROVELAND RANGER DISTRICT, STANISLAUS NATIONAL FOREST

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## ABSTRACT

High populations of grasshoppers were detected in three ponderosa pine plantations on the Stanislaus National Forest during the fall of 1983. It became apparent during the spring of 1984 that, for a variety of reasons, the plantations would not be treated with insecticide. A decison was made to monitor two of the plantations to gain information about the effects of grasshoppers in plantations.

Population estimates of the number of grasshoppers per square yard and physical measurements of seedlings were useless for predicting the level of damage. A plantation at 5,200 ft. elevation had no feeding on seedlings despite high numbers of grasshoppers. A second plantation at 4,200 ft. elevation had 7 percent seedling mortality due to grasshoppers. The amount of damage caused by grasshoppers is apparently related to the rate at which herbaceous vegetation in the plantation dries out. Three-year old ponderosa pine seedlings do not appear to be a preferred food source for grasshoppers.

Management alternatives for dealing with future infestations are discussed.

## INTRODUCTION

Grasshoppers have occasionally caused damage to young pine plantations in the Region. High numbers of grasshoppers were noted during 1979 in a recently planted 40 acre block of ponderosa pine in the Choppers Choice area of the Granite Burn (Groveland R.D., Stanislaus National Forest). Defoliation and girdling by grasshoppers caused an almost complete loss of this block in 1980. A decision was reached to aerially treat 1,500 acres of plantation with 91% malathion at 8 ounces per acre during 1981 to reduce grasshopper numbers. No further damage was noted and grasshopper numbers remained low until the fall of 1983.

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High numbers of grasshoppers were noted in three separate ponderosa pine plantations on the Stanislaus National Forest during the fall of 1983. Based on their previous experience during 1980-81, and utilizing some input from USDA-APHIS and the FPM Staff, the Forest wrote an Environmental Assessment which identified treatment of certain areas with insecticide as the preferred alternative. The areas proposed for treatment included about 1,000 acres at Choppers Choice (400 acres N.F., 600 acres Louisiana Pacific Corp.) and 16 acres at the Wilson Burn on the Groveland Ranger District and 160 acres at McCormick Meadows on the Calaveras Ranger District. For a variety of reasons which included a very restrictive time frame, uncertainty about the efficacy of some alternative treatments and a small, but very vocal opposition to any type of pesticide application, the alternative to treat grasshopper populations was not implemented in 1984.

In order to gain more information about the effects of grasshoppers on young plantations and also to document the effects of implementing the "no action" alternative, the Forest Pest Management Staff monitored two of the grasshopper-infested plantations during 1984.

## MONITORING

The two plantations monitored were Choppers Choice and Wilson Burn, both on the Groveland Ranger District. McCormick Meadows was visited in early May but was not utilized for monitoring because of difficult access.

During May 14-18, 1984, six (1/10 acre) plots were installed at Choppers Choice and two (1/40 acre) plots were installed at the Wilson Burn. Areas were considered to be at risk of grasshoppers causing mortality of tree seedlings if they visually had abundant grasshoppers and enough small seedlings to meet minimum stocking requirements. Areas that were not stocked or that had seedlings and saplings which experience has shown to be too large (about 4-5 ft.) to be killed outright by grasshoppers were not included.

Areas at risk were traversed and total acreage was calculated. Plots were installed on a predetermined grid system to cover all areas at risk. All seedlings within a plot were individually flagged and physical measurements were taken in May. Individual seedling condition as well as grasshopper population estimates were recorded on May 14-18, July 2-3, September 6 and October 15, 1984.

## OBSERVATIONS AND CONCLUSIONS

Table 1 Effect of Grasshopper Count by Date on Final Tree Condition
Table 2 Effect of Initial Tree Characteristics on Final Tree Condition
Table 3 Condition of Trees by Date
Table 4 Live Trees per Acre by Date

TABLE 1. EFFECT OF GRASSHOPPER COUNT BY DATE ON FINAL TREE CONDITION

| | GRASSHOPPERS PER SQ.YD. BY DATE | | | | GRASSHOPPER DAMAGE TO TREES ON 10/15 | | |
|---|---|---|---|---|---|---|---|
| | 5/14-18 | 7/2-3 | 9/6 | 10/15 | DEAD | MAJOR DEFOLIATION | MINOR DEFOLIATION |
| WILSON BURN | | | | | | | |
| Plot 1 | 24 | 23 | 14 | 6 | 0% | 0% | 0% |
| Plot 2 | 34 | 28 | 22 | 10 | 0% | 0 | 0 |
| CHOPPERS CHOICE | | | | | | | |
| Plot 1 | 35 | 32 | 25 | 8 | 0% | 0% | 30% |
| Plot 2 | 58 | 44 | 24 | 10 | 22.2 | 5.5 | 33.3 |
| Plot 3 | 39 | 49 | 32 | 1 | 22.2 | 0 | 11.1 |
| Plot 4 | 23 | 34 | 38 | 7 | 0 | 0 | 16.7 |
| Plot 5 | 14 | 48 | 24 | 4 | 0 | 0 | 0 |
| Plot 6 | 15 | 53 | 19 | 2 | 0 | 4.8 | 0 |

CONCLUSIONS:

1. Grasshoppers did no damage to trees at Wilson Burn despite high population counts.

2. There was no clear correlation between grasshopper counts at any time during the summer and final seedling damage at Choppers Choice.

3. Grasshopper populations vary with time, making a single count of low utlity.

TABLE 2. EFFECT OF INITIAL TREE CHARACTERISTICS ON FINAL TREE CONDITION

| CONDITION ON 10/15 | AVERAGE TREE CHARACTERISTICS ON 5/14-18 | | | | | |
|---|---|---|---|---|---|---|
| | AGE | TOTAL HEIGHT' | 1984 FLUSH' | CROWN RADIUS' | 1ST INTER-NODE CALIPER" | GROUND CALIPER" |
| WILSON BURN | | | | | | |
| Undamaged | 2.28 | .66 | .23 | .28 | .20 | .28 |
| Dead-Other Causes | 1 | .20 | .20 | .025 | - | .05 |
| CHOPPERS CHOICE | | | | | | |
| Undamaged | 3.14 | 1.12 | .27 | .43 | .25 | .45 |
| Minor Defoliation | 2.91 | 1.27 | .35 | .53 | .27 | .45 |
| Grasshopper Defol. | 3.00 | 1.40 | .35 | .35 | .30 | .53 |
| Dead-Grasshoppers | 3.00 | .95 | .20 | .37 | .20 | .41 |
| Dead-Other Causes | 3.00 | 1.08 | .45 | .33 | .23 | .35 |

CONCLUSIONS:

1. Seedlings which die are generally smaller than those which live.

2. Predefoliation size differences between 3-year old ponderosa pine seedlings are probably too subtle to predict which trees will be defoliated or killed by grasshoppers.

TABLE 3. CONDITION OF TREES BY DATE

| CONDTION OF TREES | DATE 5/14-18 | 7/2-3 | 9/6 | 10/15 |
|---|---|---|---|---|
| Undamaged | 100% | 79% | 89% | 84% |
| Minor Grasshopper Feeding | | 16 | 4 | 8 |
| Grasshopper Defoliated and/or Terminal Bud Damaged | | 4 | 1 | 1 |
| Dead Due to Grasshoppers | | | 5 | 5 |
| Dead Due to Gophers, Previous Injury or Cattle Trample | | 1 | 1 | 2 |
| TOTAL | 100% | 100% | 100% | 100% |

CONCLUSION:

1. High Grasshopper populations killed only 5 percent of the total population of 3-year old ponderosa pine monitored (7 percent of seedlings killed at Choppers Choice if Wilson Burn is excluded from calculations).

TABLE 4. LIVE TREES PER ACRE BY DATE

| | DATE 5/14-18 | 7/2-3 | 9/6 | 10/15 |
|---|---|---|---|---|
| WILSON BURN | | | | |
| PLOT 1 | 1440 | 1440 | 1440 | 1440 |
| PLOT 2 | 440 | 400 | 400 | 400 |
| CHOPPERS CHOICE | | | | |
| PLOT 1 | 100 | 100 | 100 | 100 |
| PLOT 2 | 180 | 180 | 140 | 140 |
| PLOT 3 | 90 | 90 | 70 | 70 |
| PLOT 4 | 60 | 60 | 60 | 60 |
| PLOT 5 | 220 | 220 | 220 | 210 |
| PLOT 6 | 210 | 200 | 200 | 200 |

CONCLUSION:

1. Plots which were above minimal stocking prior to grasshopper defoliation were still above minimal stocking after defoliation.

## DISCUSSION

The probability of grasshoppers causing damage to a plantation appears to depend on a number of factors, and observations on the Stanislaus National Forest during 1984 as well as other areas of California in recent years have provided a few clues about them. Factors which seem to influence plantation defoliation include the number of grasshoppers present, amount of herbaceous vegetation and speed at which it dries, and the size and species of trees.

Grasshoppers are present at low levels in most forest areas which have loose enough soil for egg laying and a minimal amount of grass or forbs for food. If the grass and forb cover increases because of a fire or harvest activities, the grasshopper population may also increase. When sites which have been in herbaceous vegetation are prepared in the fall with little soil disturbance, there may be many grasshopper eggs which survive in the soil and hatch the following spring. USDA-APHIS has established a standard of 8 grasshoppers per square yard as the threshold at which grasshoppers cause an economic loss on public grazing land in the western states. The number of grasshoppers required to damage seedlings is not known, and is likely to vary with other factors, but for 3-year old ponderosa pine, the population apparently has to exceed 30-40 grasshoppers per square yard.

The amount of herbaceous vegetation and speed at which it dries during the summer appears to influence the probability of defoliation. The first few nymphal stages can't feed on conifers, so adequate herbaceous vegetation must be present to sustain them for several weeks. The older nymphs tend to avoid conifer foliage unless it is in direct contact with herbaceous vegetation. Older nymphs and adults may turn to conifers once all other vegetation has dried. Areas where the vegetation dries early in the season seem more prone to damage. Elevation is a key factor in the speed at which the vegetation dries. The Wilson Burn, which is at 5,200 feet elevation, maintained some green herbaceous vegetation into September, 1984 and there was no feeding on the conifer seedlings. Vegetation at Choppers Choice at 4,200 feet elevation began to dry out by early July in 1984 and there was 7 percent seedling mortality due to grasshoppers. According to Duncan Wurm, Culturist on the Calaveras Ranger District, plantation survival at McCormick Meadows at 3,400 feet elevation was only about 20 percent. Grasshoppers were responsible for much of the mortality, but vegetative competition, gophers and deer browsing also played a part. Weather not only has a role in the rate at which vegetation dries, but it also influences the survival of grasshopper natural enemies. Grasshopper diseases and parasites survive and spread best during cool, moist weather. Many outbreaks of grasshoppers in California forest plantations have coincided with warm, dry springs.

In California, grasshoppers have been recorded feeding on red and white fir, and lodgepole, ponderosa and sugar pines. During the first and second growing seasons, most species of conifers are readily killed by grasshopper feeding. This is because the seedlings have small root systems with little food reserves, so a single defoliation may be sufficient to kill them. Also, the buds and bark of young seedlings are tender and may be destroyed by grasshopper feeding. Conifers taller than 4-5 feet have been defoliated by grasshoppers only rarely, and relatively few of them have died. Ponderosa pine which have reached sapling size generally have enough food reserves to survive one year of

defoliation and their bark and buds are usually too tough to be damaged by grasshoppers. The true firs and sugar pine tend to remain susceptible to grasshopper damage longer than the hard pines because they have thin, soft bark and smaller buds.

## MANAGEMENT ALTERNATIVES

1. Do Nothing. If no special consideration is given to grasshoppers during plantation establishment and management, most plantations will not have any losses due to grasshoppers. Occasionally there will be plantations which fail due to grasshoppers during the first few years after planting. These losses will probably occur during warm, dry springs on sites which have been in grass and forbs for some time and which are located at low to middle elevations. These losses will probably have a low impact if considered Region-wide, but on a local scale the impact will be significant.

2. Treat ongoing grasshopper infestations. If a grasshopper infestation is detected before significant damage has occurred to a plantation, some measures may limit the loss.

A. Scalp around seedlings. This would buy a tiny bit of protection. If the grass was not in physical contact with the seedlings, the grasshoppers would not be able to step from it to the crown of the seedlings. If done solely for the purpose of protection from grasshoppers, it is unlikely to be cost-effective.

B. Herbicide treatment of vegetation. Grasshoppers hatch continuously from late-April through mid-June. The young nymphs need to feed on herbaceous vegetation for several weeks before they can feed on conifers. If most of the herbaceous vegetation was killed with herbicide before May or early June, the young grasshopper nymphs would starve. Herbicide treatment has the potential to keep grasshopper populations at low levels for a relatively long time, depending on the ability of vegetation to re-sprout or seed into the plantation. A pesticide-use proposal and environmental documentation would be required.

C. Insecticide treatments. Bran bait treated with carbaryl insecticide can be spread by hand in the plantation. Experience indicates that treating a buffer of about 100 feet beyond the edge of the plantation is usually sufficient to prevent seedling mortality, although some feeding may occur. Treatment early in the year when the grass is short tends to be relatively effective. Later treatments after the grass is tall are not as effective because the bait sinks to the ground and the grasshoppers are reluctant to climb down to get it.

Malathion (91% technical material at 8 ounces per acre) has been used to reduce grasshopper numbers and prevent seedling damage. This material has been applied by helicopter in the past, although it may be adaptable to low volume ground equipment such as the "Herbi".

Carbaryl (Sevin) and acephate (Orthene) can also be aerially applied to suppress grasshoppers. These materials offer no particular advantages over malathion. Malathion is generally the material used by USDA-APHIS for grasshopper control because it is easily applied by aircraft as an ultra low volume (ULV), is readily available, gives the desired results and degrades quickly.

Insecticide treatments occassionally keep populations low enough to prevent damage for two years, but it can't be counted on. Because the treatments don't do anything to alter the environmental conditions that caused the outbreak, it is likely that populations will increase again. Insecticide treatment would require the submission of a pesticide-use proposal and preparation of adequate environmental documentation.

3. Prevent grasshopper infestations. Some actions can be taken in advance to reduce the chance of a grasshopper infestation. Because grasshopper infestations tend to be sporadic, actions taken solely to prevent grasshoppers may not be cost-effective. However, some activities which reduce the risk of grasshopper damage also tend to increase plantation survival and seedling growth. The total benefit of these management activities tend to outweigh the costs.

A. Avoid seeding grass. Recent burns are often seeded with grass for erosion control. It not only costs money to seed an area with grass, but also additional money must be spent later to control grass which is in competition with seedlings and to control gophers and grasshoppers for which the grass provides ideal habitat. In many cases, all or part of the burn is on relatively gentle terrain or on soils which are not highly erodible. Pest problems would be fewer and some monetary and manpower savings would occur if grass seeding was limited to areas with a high risk of erosion.

B. Avoid converting brush to grass. Some site preparation techniques such as broadcast burning, crush and burn, and brown and burn tend to convert brush cover to grass and forb cover. Unless effective techniques of dealing with the herbaceous vegetation are available, losses due to vegetative competition, gophers and grasshoppers may be greater than those prior to treatment.

C. Adequate site preparation. Site preparation can influence grasshopper populations directly as well as their habitat.

1. Fire. A ground fire just prior to planting would remove some of the food the early nymphal stages need to survive. One experience in the central Sierra's with a ground fire in late April or early May for site preparation indicates the fire was not hot enough to kill many of the eggs in the soil, and vegetation regrowth was rapid enough to support a fairly large population of grasshoppers. The use of fire for site preparation in an area prone to grasshopper infestations may be counterproductive because burning sometimes favors reproduction of vegetation necessary for survival of young grasshoppers.

2. Mechanical. Mechanical site preparation methods such as the Hydro-Axe, Track-Mack and simple grader blades which reduce vegetation without significantly distrubing the soil may leave large numbers of grasshopper eggs

in the soil to hatch later. If enough vegetation sprouts or germinates to sustain the first few grasshopper nymphal instars, the resulting plantation failure may not be much different from the effects of having no site preparation at all.

Site preparation methods which disturb the soil, such as a brush rake, can reduce the number of eggs that hatch by burying some deeply and exposing others. Although brush rakes are effective for temporary vegetation control, they are not commonly used where herbaceous vegetation predominates.

Discing prior to planting gives fairly effective grasshopper control for a year. It buries some grasshopper eggs too deeply to hatch and brings many eggs to the surface where they dry out or are eaten by predators. It also reduces the amount of vegetation available to the survivors. High cost, steep slopes, rocks and stumps limit its usefulness.

3. Herbicide. Various herbicides can be used to reduce vegetation before planting for site preparation and after planting for release. Because native vegetation often includes a variety of species of grasses, forbs and ferns, it may be necessary to use more than one herbicide or more than one application to successfully reduce herbaceous grasshopper food on a site. Grasshoppers do not become truely migratory under the conditions found in plantations in California, although they may move up to 100 feet in search of food. This means that any vegetation treatment to reduce grasshopper habitat should be extended beyond the edge of the plantation to be effective. Seedlings remain susceptible to grasshopper damage through the second growing season and occassionally into the third. It may be prudent to survey plantations which seem to be at risk for signs of high numbers of grasshoppers or abundant grasshopper food for several years after planting. The use of herbicides would require environmental documentation and a pesticide-use proposal.

D. Surveillance. By itself, surveillance will not prevent grasshopper infestations, but if done properly it can give a warning in time to treat an infestation before significant damage occurs. Although extra surveillance would generate extra costs, these would probably be lower than the cost of replacing a plantation and may, in fact, be necessary to meet the monitoring requirements of NFMA. Costs can be kept to a minimum by restricting the inspection to a simple walk-through and by inspecting only those plantations which have a high risk of damage by grasshoppers.

Inspections would be most important in plantations at low to middle elevations, particularly on sites which previously had, or currently have, grass or forb cover. More time and effort should be spent during warm, dry springs because these conditions are favorable for grasshopper population increases. The first two or three growing seasons are the most critical to plantation survival because grasshoppers are capable of killing young seedlings by consuming tender bark and buds. Grasshoppers have defoliated 3 to 8-year old seedlings in the past, but this has generally resulted in growth loss rather than mortality.

It is important to know as early as possible in the spring whether a high grasshopper population is present. Depending on weather and elevation, grasshopper species that damage plantations hatch from late-April through mid-June.

This often coincides with the time that native annual grasses and forbs are about an inch or two high. If Forest personnel detect what subjectively seems to be a high population level, the Forest Pest Management Staff is available to assist with a population assessment and to discuss the available management alternatives.